

Confirmation of the presence of *Vanilla hartii* Rolfe (Orchidaceae, Vanilloideae) in Brazil

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Abstract

We confirm the occurrence of *Vanilla hartii* Rolfe in Brazil. This species was collected in FLONA Carajás, Amazonia, at the municipality of Parauapebas, state of Pará. This work contributes to the knowledge of the geographical distribution of this rare vanilla.

Keywords

Brazilian Amazon, new occurrence, orchids.

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Introduction

The orchid family encompasses 27,135 accepted species, 2,465 unconfirmed taxa, and 925 genera distributed worldwide (Govaerts et al. 2020; Tropicos 2020). In Brazil, more than 2,661 species and 244 genera occur, including the pantropical *Vanilla* Plumier ex Miller (BFG 2015; Brazilian Flora Project 2020).

Vanilla encompasses 103 accepted species and 21 unconfirmed taxa. The genus *Vanilla* includes hemiepiphytic, terrestrial, or occasionally epiphytic species. *Vanilla* species are found in tropical and subtropical regions of Africa, Asia, America, and the Pacific islands (Cameron 2003; Soto-Arenas 2003; Soto-Arenas and Cribb 2010; Soto-Arenas and Dressler 2010; Pansarin et al. 2012; Chase et al. 2015; Govaerts et al. 2020; Tropicos 2020). *Vanilla* fruits are a source of the flavor

vanillin. Vanillin is obtained from fruits of some *Vanilla* species, especially *V. planifolia* Jacks. ex Andrews and *V. pompona* Schiede. The flowers of *Vanilla* species can be white, greenish-white, cream, or more rarely yellow, and they usually last less than 12 hours (Cameron 2003; Soto-Arenas 2003; Soto-Arenas and Cribb 2010; Soto-Arenas and Dressler 2010).

In Brazil 37 species of *Vanilla* occur, but *Vanilla hartii* Rolfe is not considered native to Brazil (BFG 2015; Brazilian Flora Project 2020; Specieslink 2020). The possible occurrence of *V. hartii* in Brazil has been inferred on basis on a single sterile specimen (Soto Arenas and Cribb (2010), Soto Arenas and Dressler (2010), Tropicos (2020), and Govaerts et al. (2020).

Vanilla hartii is a hemiepiphyte species with cream-

colored flowers. The labellum possesses a penicillate callus, and the margin of the lip apex is remarkably crenulated. The few-flowered racemes produce fragrant flowers. *Vanilla hartii* belongs to the subgenus *Xanata*, section *Xanata*, within the *Vanilla trigonocarpa* group (Soto Arenas and Cribb 2010).

We provide information that confirms the occurrence of *V. hartii* in Brazil. Additionally, we deposited a fertile and georeferenced voucher in the Laboratório de Biologia Molecular e Biossistemática de Plantas (LBMBP) dried collection, provide a detailed morphological description of this species based on fresh material, and provide a photographic record of live plants of this rare species.

Methods

Study site. The Province of Carajás is in the Serra dos Carajás, southeastern Pará, Brazil. The Serra dos Carajás (06°03'49"S, 049°54'58"W, 500–700 m a.s.l.), is within the municipalities of São Felix do Xingu, Ourilândia do Norte, Curianópolis, Eldorado dos Carajás, Parauapebas, Canaã dos Carajás, and Água Azul do Norte. The Carajás region comprises native open vegetation growing on ferruginous rocks (5% of the Serra dos Carajás) and native forests typical to the Amazon Biome (STPC 2016; Viana et al. 2016). Botanical studies in this region began in 1969, shortly after the discovery of the mineral potential of the Province of Carajás in 1967 (Viana et al. 2016). These studies intensified more recently in 2014 with the “Flora das cangas da Serra dos Carajás, Pará, Brasil” project, which is the result of cooperation between the Museu Paraense Emílio Goeldi (MPEG) and the Vale® Technological Institute–Sustainable Development (ITVDS), responsible for the preservation and management of the environmental preservation of Serra de Carajás (Viana et al. 2016). The Carajás National Forest (FLONA Carajás), created in February 1998, belongs to Province of Carajás and has 351,632 ha and a high wealth of fauna and flora, which is still under study (STPC 2016). A recent floristic survey by Viana et al. (2016) found about 80 species of ferns and lycophytes belonging to 24 families and 64 genera, and 503 species of angiosperms belonging to 111 families. However, studies are still in progress, and it is estimated that the number of angiosperms may reach 600 species. Among the botanical species of FLONA Carajás, the endemic cryptogams *Blechnum areolatum* V.A.O. Dittrich & Salino, *Isoetes cangae* J.B.S. Pereira, Salino & Stützel, and *I. serracarajensis* J.B.S. Pereira, Salino & Stützel (Isoetaceae) and also the endemic phanerogams *Borreria elaiosulcata* E.L. Cabral & L.M. Miguel (Rubiaceae), *B. carajasensis* E.L. Cabral & L.M. Miguel (Rubiaceae), *Philodendron carajasense* E.G. Gonç. & A.J. Arruda (Araceae), and *Sinningia minima* A.O. Araujo & Chautems (Gesneriaceae). Two new monospecific genera, *Carajasia cangae* R.M. Salas, E.L. Cabral & Dessein (Rubiaceae) and *Brasilianthus carajasensis* Almeda

& Michelangeli (Melastomataceae) were also described. The bioclimate is Amazonian Tropical Pluviseasonal (Rivas-Martinez et al. 2011). The summer (October to December) is rainy, and the winter (June to September) is dry. The average annual precipitation is approximately 2,000 mm, while the mean annual temperature is 25–26 °C (Alvares et al. 2013).

Data collection. The floristic survey was carried out between November 2012 and September 2013 in the Serra dos Carajás. *Vanilla hartii* was collected in the municipality of Parauapebas, on the plateau of the Alemão region, at an altitude of about 590 m, in a well-preserved area of native Amazon forest. Two specimens of *V. hartii* were collected, and the plants were cultivated at the Orchid House of the Laboratory of Molecular Biology and Systematics of Plants, University of São Paulo (FFCLRP-USP).

Data processing. *Vanilla hartii* was photographed with a digital camera, and the flowers of *V. hartii* described with the use of a Leica S8 APO stereomicroscope. One specimen of *V. hartii* was vouchered following the procedures of Fidalgo and Bononi (1989) and included at the LBMBP herbarium, University of São Paulo (FFCLRP-USP), Ribeirão Preto, São Paulo, Brazil. The geographical distribution follows the Brazilian Flora Project database (2020), SpeciesLink (2020), Soto Arenas and Cribb (2010), Soto Arenas and Dressler (2010), and Tropicos (2020). The acronyms of the consulted herbaria (AMES, AMO, BRH, F, HAMAB, LBMBP, MG, MO, SEL) follow Thiers (2020).

Figure 2 was edited using software Adobe Photoshop CS5 12.0 (Adobe Systems Incorporated). The distribution map was based on records of *V. hartii* from 11 countries (Tropicos 2020), as follow: Belize, Costa Rica, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, and Trinidad and Tobago. Only one occurrence record point was adopted for each of these 11 countries to show the distribution of *V. hartii*, as the information available in Tropicos (2020) does not provide complete data on the occurrence records of this species. There was only one mention of the occurrence of *V. hartii* in Mexico (citing only the municipality of Chiapas) and Trinidad and Tobago (no location); both occurrence records lack geographic coordinates (Tropicos 2020). The geographical coordinates of the specimens collected at FLONA Carajás and cultivated at the Orchid House of the FFCLRP-USP were determined using a GPS receiver. The map also includes the coordinates of a dubious record of a sterile exsiccate of *V. hartii* (B.V. Rabelo, C.P. Penafort 720 (HAMAB) (SpeciesLink 2020). The map was prepared using QGIS v. 2.14.0 Essen (QGIS Development Team 2009), using the UTM zone 23S coordinate system and GCS South American Datum 1969.

Results

During the fieldwork at FLONA Carajás, in an area of the Brazilian Amazon rainforest, between November 2012 and September 2013, a specimen of *Vanilla* was collected. Blooming in cultivation, this specimen was identified as *Vanilla hartii*, confirming the occurrence of this species in northern Brazil (Fig. 1).

***Vanilla hartii* Rolfe**, Bull. Misc. Inform. Kew 1899 (151–152): 133 (1901)

Figure 2

Type: Trinidad, Cabasterre Arima, Hart 6355, holo. K!, iso. AMES (67785)!

Synonym: *V. lepriurii* Portères, Bull. Soc. Bot. France 98: 94. 1951.

Type: “Guyane Française: Cayenne, dans les forêts humides, Leprieur (s.n.) (holo. P not seen, drawing!).

New record. BRAZIL – Pará • E.R. Pansarin 1557 (LBMBP); Parauapebas, Serra dos Carajás, entorno da Mina do Alemão; 06°03'40"S, 050°32'53"W, 590 m a.s.l.; 15 Dec. 2019; fl.

This new Brazilian record increases the geographical distribution of *V. hartii* by approximately 850 km south from the previous record in French Guiana (Fig. 1).

Additional data. BRAZIL – Amapá • B.V. Rabelo, C.P. Penafort 720 (MG, sterile) (exsiccate lost); Macapá; 00°22'00"N, 051°03'59"W; 18 Oct. 1980, without fl. •

Same data B.V. Rabelo, C.P. Penafort 720 (HAMAB, sterile); without fl.

BELIZE – Toledo • G. Davidse 36251 (BRH, MO); 16°31'05"N, 088°54'11"W; 24 May 1996; fl.

COSTA RICA – Heredia • M.H. Grayum, T. Ray 7998 (MO); 10°27'00"N, 084°03'36"W; 24 Jan. 1987; fl.

EL SALVADOR • without precise location; no data from the exsiccate; 03°55'00"N, 053°05'00"W; no date.

FRENCH GUYANA • no precise location; no data from the voucher; 03°55'00"N, 053°05'00"W; no date.

GUATEMALA • J.A. Steyermark 38944 (F); without precise location; 15°46'30"N, 090°13'30"W; no date.

GUYANA • no precise location; no data from the exsiccate; 04°54'30"N, 058°55'00"W; no date.

HONDURAS • P.C. Standley 52824 (AMES); without precise location; 15°13'30"N, 086°15'30"W; no date.

MEXICO – Chiapas • M.A. Soto Arenas et al. 9731 (AMO); without geographic coordinates; no date.

NICARAGUA – Atlántico Sur • W.D. Stevens 20021 (MO, SEL); 11°36'00"N, 083°40'00"W; 7 Apr. 1981; fl.

PANAMA • P.C. Standley 29353 (AMES); without location; 08°26'30"N, 080°06'30"W; no date.

TRINIDAD AND TOBAGO • no precise location; no data from the exsiccate; no date.

This imprecise collection data of these records probably is reflective of the infrequency that *V. hartii* is found and is also due the lack of standardization of voucher data. However, the 12 countries mentioned, including Brazil,

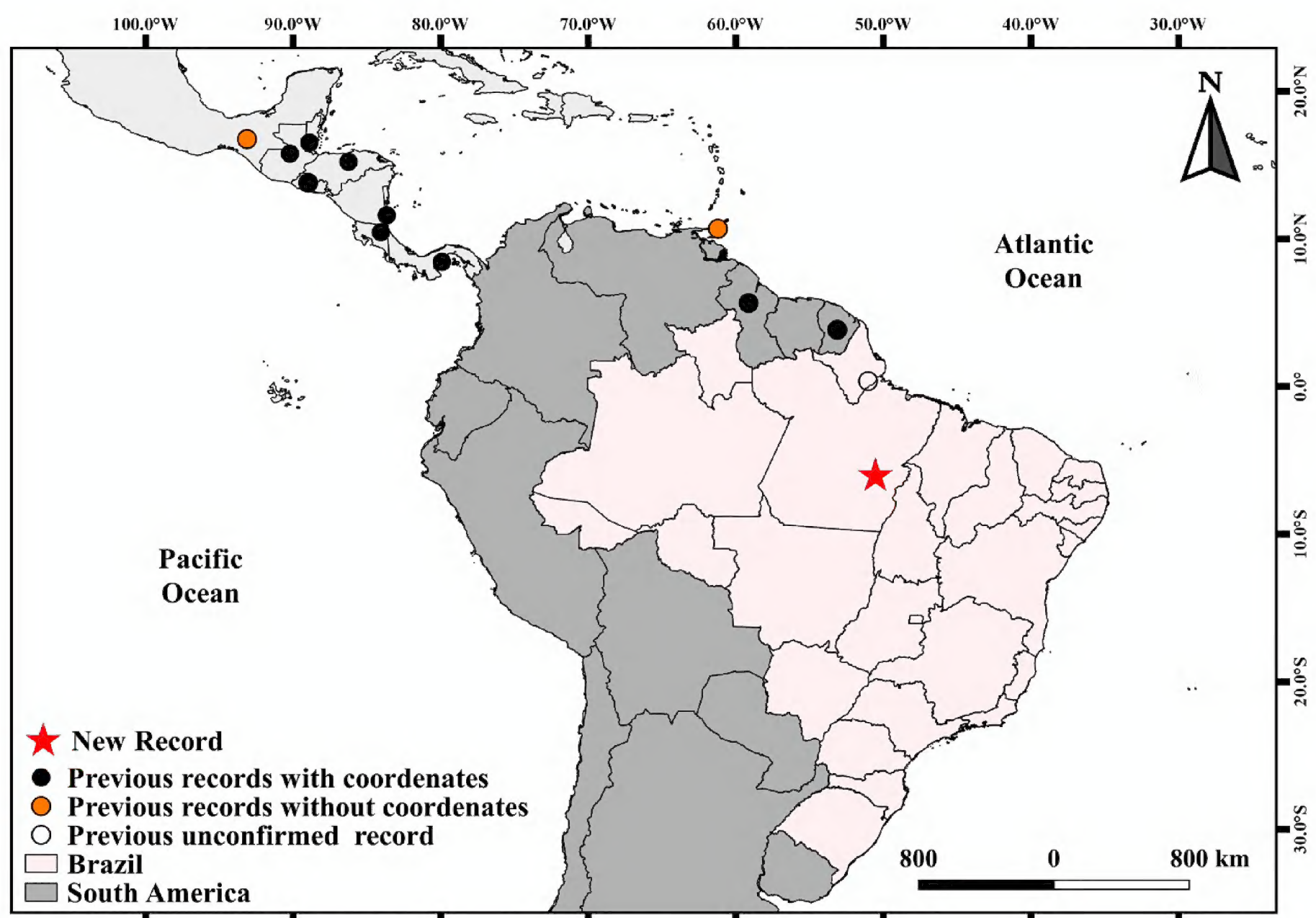


Figure 1. Geographic distribution of *Vanilla hartii* in the Americas, highlighting the new record in Floresta Nacional Carajás (FLONA Carajás), South America, Brazilian Amazon (red star).



Figure 2. *Vanilla hartii*. **A.** Part of plant in bloom. **B.** Flower in front view. **C.** Flower in lateral view. **D.** Part of the dissected perianth. **E.** Labellum distended showing the penicillate callus. **F.** Part of the ovary and column in lateral view showing the rostellum and the anther cap.

can be used as a basis for mapping the known geographical distribution of *V. hartii* in the Americas (Fig. 1).

Identification. *Vanilla hartii* is a hemiepiphyte species. The labellum possesses a central penicillate callosity. The margin of the labellum apex is crenulated. The flowers are fragrant and possess an evident nectary at the base. *Vanilla hartii* belongs to the subgenus *Xanata*, section *Xanata*, within the *Vanilla trigonocarpa* group that includes *V. espondiae* Soto Arenas, *V. sprucei* Rolfe and *V. trigonocarpa* Hoehne. *Vanilla hartii* differs from these three species of the *V. trigonocarpa* group mainly in having smaller flowers, stem, and leaves (Soto Arenas and Cribb 2010).

Morphological description. Hemiepiphytic herb, up to 10 m long. Aerial roots terete, brownish (0.1–0.2 cm in diameter \times 1–1.5 cm in length), flattened, one per node. Stem 0.6–0.8 cm in diameter, green, thin, longitudinally grooved, cylindrical; internodes 11.3–17.0 cm in length. Leaves green, conspicuously petiolate, alternate, 6.5–8.0 cm long \times 2.5–3.5 cm wide, elliptical, rounded at base, coriaceous, apex acute, facing down. Inflorescence lateral, racemose, short, axillary, 2.0–3.0 cm long, with 5–10 flowers opening in succession; rachis 0.6–1.4 cm long. Flower resupinate, ephemeral, fragrant, ca 4.5 cm long, sepals and petals whitish-green, lip white; dorsal sepal 4.9–5.2 cm long \times 0.8–1.1 cm wide, oblanceolate, slightly concave, apex acute; lateral sepals 5.0–5.3 cm long \times 0.9–1.1 cm wide, oblanceolate, apex acute; petals 4.9–5.1 cm long \times 0.7–0.9 cm wide, oblanceolate, arcuate, apex subacute to rounded; labellum 4.4–4.7 cm long \times 2.3–2.4 cm wide, white, infundibuliform, fused with column base, apex retrorse, margins undulate and denticulate, basally gibbous and internally with orange, longitudinal veins; penicillate callus (0.4 \times 0.3 cm), with white trichomes; column elongated, semicylindrical, 3.8–4.0 cm long \times 0.2–0.3 cm wide, with two lateral wings, pubescent on the abaxial surface; anther obovoid, versatile, 0.3 \times 0.3 cm; stigma trilobed, rostellum flabellate. Ovary and pedicel 2.9–3.0 cm long \times 0.2 cm thick, terete, green, incurved. Fruit not seen.

Discussion

According to data from the Brazilian Flora Project (2020) and from SpeciesLink (2020), 37 species of *Vanilla* occur in Brazil. However, *V. hartii* never has been recorded in the Brazilian flora. Therefore, the record of *V. hartii* brings the number *Vanilla* to 38 species in Brazil and 12 species for the state of Pará, northern Brazil (Brazilian Flora Project 2020).

Vanilla hartii has been found in a native forest area of the FLONA Carajás, Brazilian Amazon forest. The plants occur as hemiepiphytes in the Alemão Plateau, at about 590 m a.s.l. According to the Tropicos database (2020), Soto-Arenas and Cribb (2010), and Soto-Arenas and Dressler (2010), *V. hartii* occurs in Belize, Costa Rica, El Salvador, French Guiana, Guatemala, Guyana,

Honduras, Mexico, Nicaragua, Panama, and Trinidad and Tobago.

According to the Tropicos database (2020), *V. hartii* also occurs in Brazil, in the state of Mato Grosso. However, no voucher is present to confirm this information. Soto-Arenas and Dressler (2010) pointed out that *V. hartii* has a “probable occurrence for Brazil” but no information is provided. Based on a DNA analysis of a sterile voucher (i.e. Rabelo & Penafort 720, MG, sterile, 18 Oct. 1980), Soto-Arenas and Cribb (2010) reported the occurrence of *V. hartii* in Brazil. However, this voucher does not allow proper identification, because the vegetative characters of *Vanilla* species sometimes overlap. Furthermore, although there have been recent advances in the molecular techniques in the last decade, the determination of a taxon based exclusively on DNA analyses is almost impossible (Li et al. 2015; Chen et al. 2020). The accuracy of molecular techniques for species determination is around 70% (Costion et al. 2011).

Another questionable occurrence record of *V. hartii* in Brazil is based on the voucher Rabelo & Penafort 720, which is no longer available in the collection of the herbarium MG. It was probably used for the aforementioned DNA analysis cited by Soto-Arenas and Cribb (2010). A duplicate of this voucher was deposited in the Amapaense Herbarium as *Vanilla* sp. (HAMAB: Rabelo, B.V.; Penafort, C.P. 720, 18 Oct. 1980), but this material is also sterile. Therefore, based on this information and data from the Brazilian Flora Project (2020), Tropicos database (2020), and Species-Link (2020), the material of *V. hartii* reported here is the first fertile Brazilian specimen deposited in a herbarium.

Although *V. hartii* is distributed from Mexico to northern South America (Tropicos 2020), it seems to be uncommon. The flowers of *Vanilla* species are ephemeral, and this possibly contributes to the scarcity of *V. hartii* specimens in herbaria.

We did not observe fruits of *V. hartii* because the cultivated plant produced no vanilla pods when its flowers are self-pollinated (E.R. Pansarin pers. obs.). However, based on information from Soto-Arenas and Cribb (2010), the fruit of *V. hartii* is elongate, cylindrical, slightly calyculate, linear-fusiform (9.2–140 cm long \times 0.4–0.5 cm thick), not fleshy, dehiscent along two lines, and fragrant.

More collection efforts are needed to increase the knowledge on *Vanilla* species and their distribution by reducing geographical gaps (BFG 2015; Brazilian Flora Project 2020).

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Authors' Contributions

EPF collected the specimen; ERP photographed the specimen; ERP and AWCF identified the species; and ERP, EVP, and AWCF wrote the text.

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